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Research on Science Education

Secretary's Science Summit

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Valued outcomes

- Science literacy
- Scientists

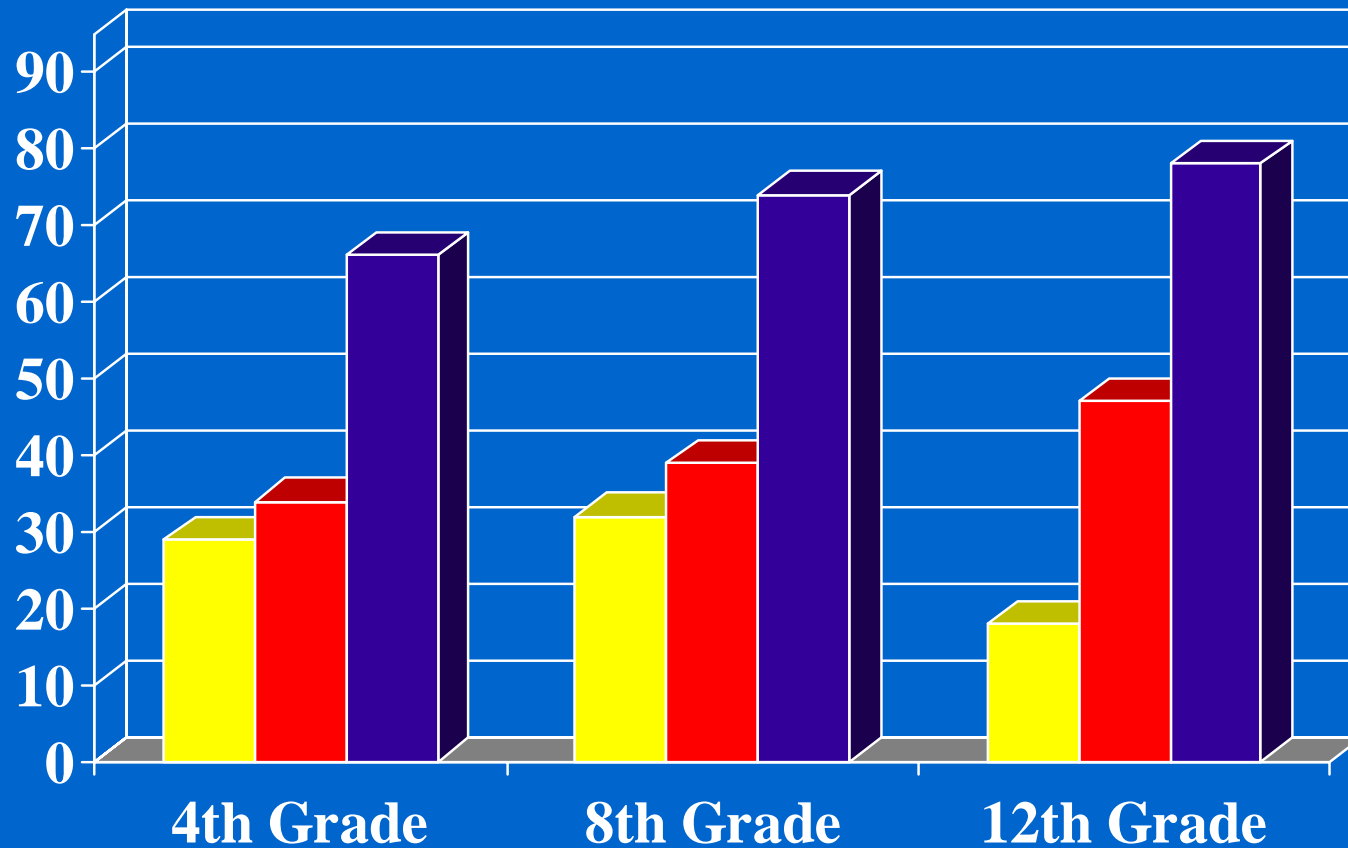


How are we doing?

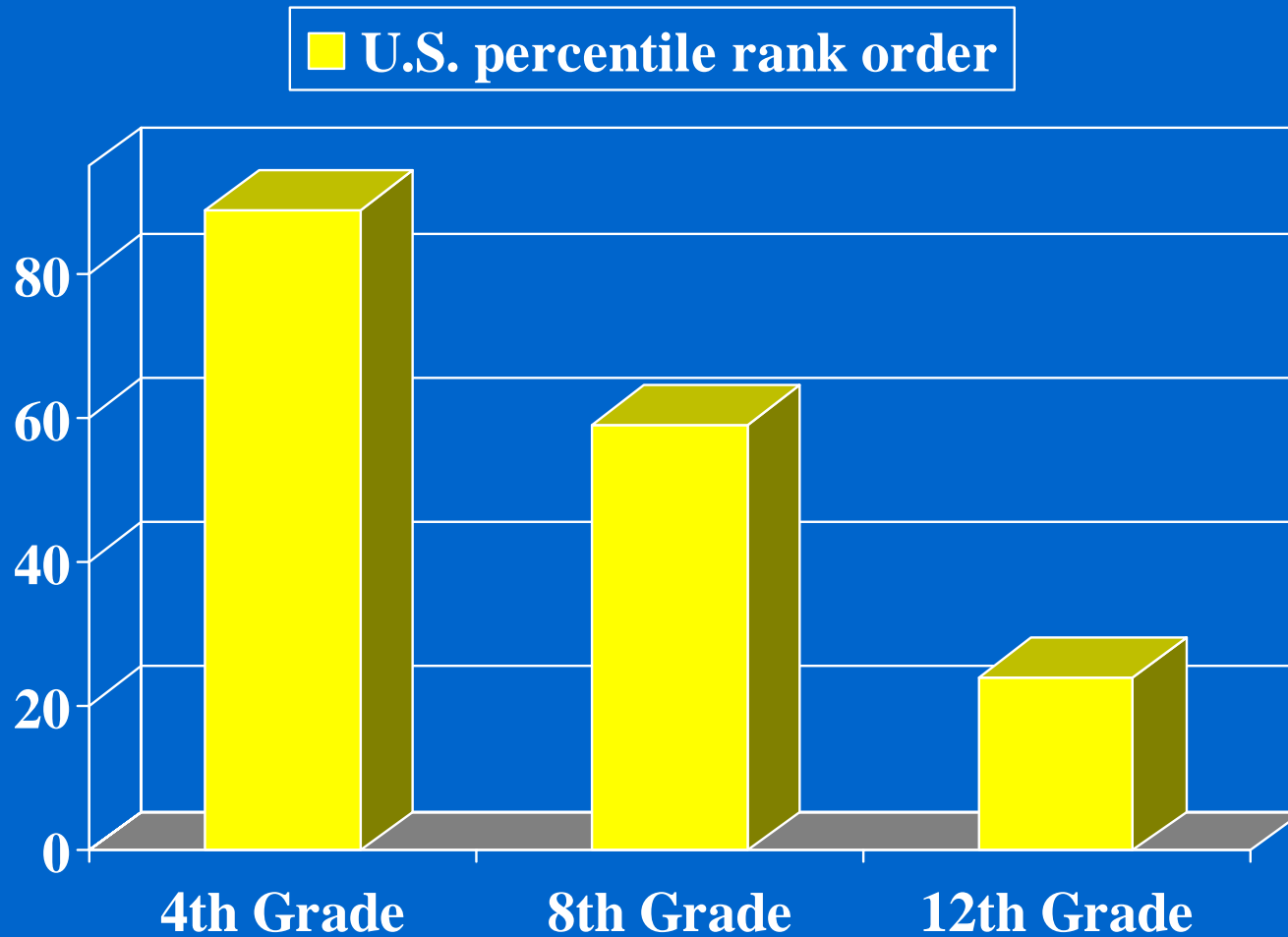
- Assessment results
- Transcript studies
- Post-secondary career paths

NAEP 2000 Proficiency

■ Proficient ■ Below Basic ■ Below Basic Af Am



TIMSS Science 1995



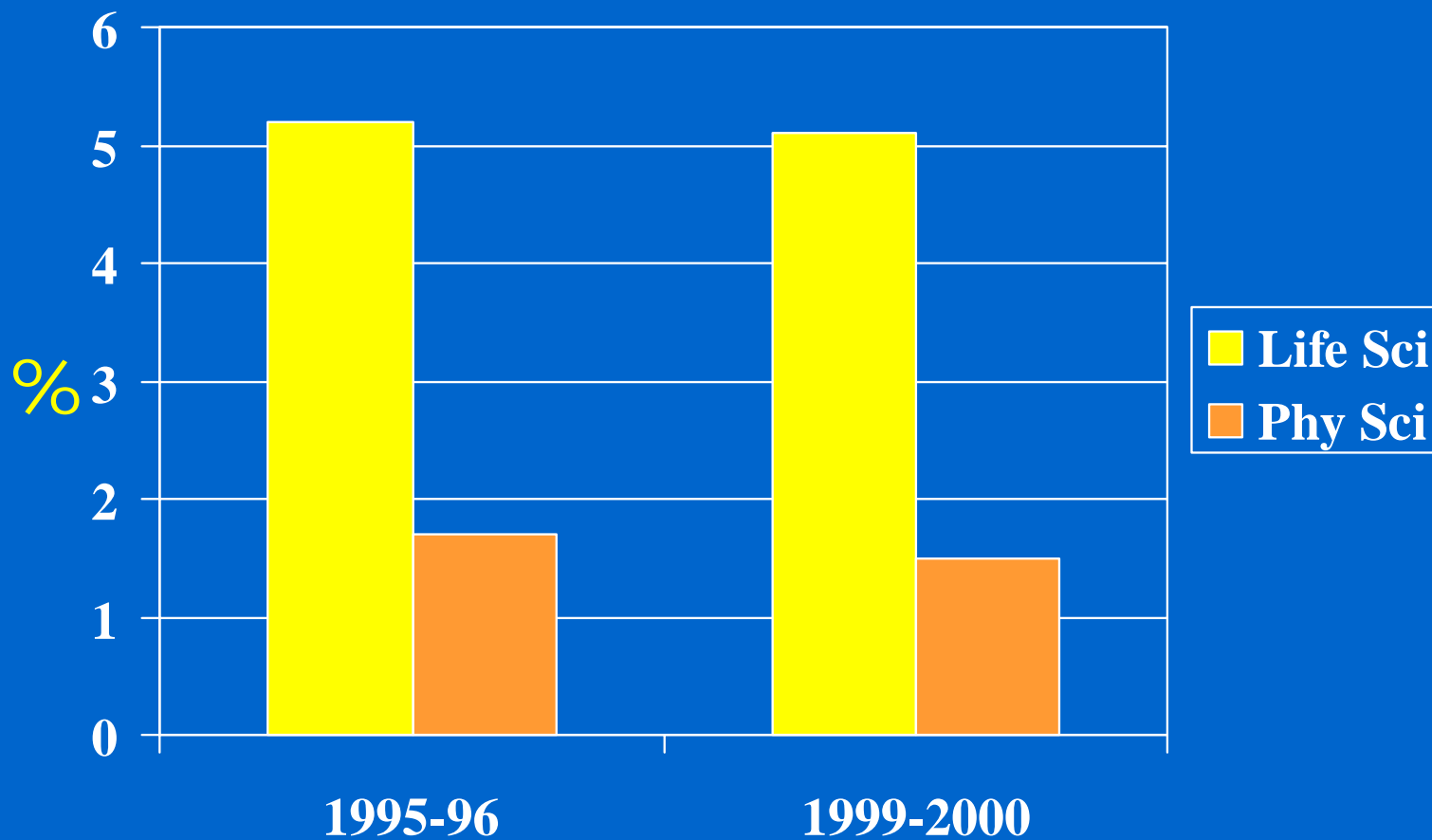
Transcript studies

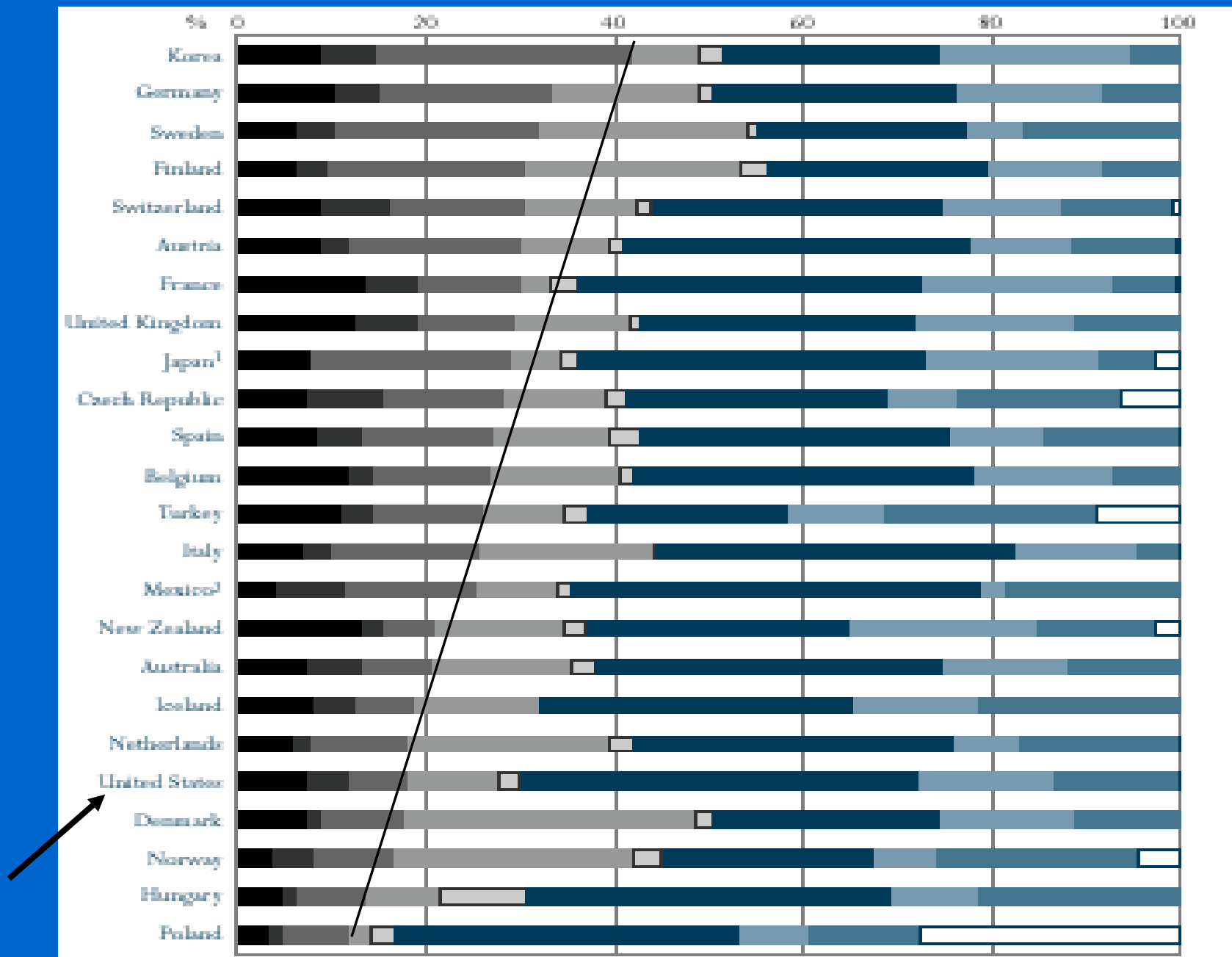
One course each in:

Algebra II/Biology/Chemistry/Physics

- 30 % (20%) of all (Black) students
- 15 % (11%) of all (Black) general academic students
- 40 % (32%) of all (Black) college preparatory students

Bachelor's Degrees Conferred





What can we do to improve?



Curriculum

A+ Counties' Standards

Topic	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Organs, tissues			j	j	j	j	j	j
Physical properties of matter			j	j	j	j	j	j
Plants, fungi			j	j	j	j	j	f
Animal types			j	j	j	j	f	j
Classification of matter			f	f	f	f	j	j
Rocks, soil			f	f	f	f	j	j
Light			f				j	j
Electricity				f		f	j	j
Life cycles				j	j	j	j	j
Physical changes of matter				j	j	j	j	j
Heat & temperature				j	j	j	j	j
Bodies of water				f	f	f	j	j
Interdependence of life					f	j	f	f
Habitats & niches					f	f	f	f
Biomes & ecosystems					f	j	f	f
Reproduction					f			f
Time, space, motion					j	j	j	j
Types of forces					f	f	j	j
Weather & climate					f	f	j	j
Planets in the solar system					f	f	f	f
Magnetism						j	j	j
Earth's Composition						f	j	j
Organism energy handling						f	f	j
Resource conservation						f	f	j
Earth in the solar system						f	f	f
Atoms, ions, molecules							j	j
Chemical properties of matter							j	j
Chemical changes of matter							j	j
Physical cycles							f	j
Land forms							f	j
Material & energy conservation							f	j
Explain physical changes							f	f
Pollution							f	j
Atmosphere							f	f
Sound & vibration							f	f
Cells							f	f
Human nutrition							f	f
Building & breaking								j
Energy types and conversions								j
Dynamics of motion								f

Typical U.S. State Standard

Topic	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Organs, tissues	j	j	j	j	j	j	j	j
Physical properties of matter	j	j	j	j	j	j	j	j
Plants, fungi	j	j	j	j	j	j	j	j
Animal types	j	j	j	j	j	j	j	j
Classification of matter	j	j	j	j	j	j	j	j
Rocks, soil	j	j	j	j	j	j	j	j
Light	j	j	j	j	j	j	j	j
Electricity	j	j	j	j	j	j	j	j
Life cycles	j	j	j	j	j	j	j	j
Physical changes of matter	j	j	j	j	j	j	j	j
Heat & temperature	j	j	j	j	j	j	j	j
Bodies of water	j	j	j	j	j	j	j	j
Interdependence of life	j	j	j	j	j	j	j	j
Habitats & niches	j	j	j	j	j	j	j	j
Biomes & ecosystems	j	j	j	j	j	j	j	j
Reproduction	j	j	j	j	j	j	j	j
Time, space, motion	j	j	j	j	j	j	j	j
Types of forces	j	j	j	j	j	j	j	j
Weather & climate	j	j	j	j	j	j	j	j
Planets in the solar system	j	j	j	j	j	j	j	j
Magnetism	j	j	j	j	j	j	j	j
Earth's Composition	j	j	j	j	j	j	j	j
Organism energy handling	j	j	j	j	j	j	j	j
Resource conservation	j	j	j	j	j	j	j	j
Earth in the solar system	j	j	j	j	j	j	j	j
Atoms, ions, molecules	j	j	j	j	j	j	j	j
Chemical properties of matter	j	j	j	j	j	j	j	j
Chemical changes of matter	j	j	j	j	j	j	j	j
Physical cycles	j	j	j	j	j	j	j	j
Land forms	j	j	j	j	j	j	j	j
Material & energy conservation	j	j	j	j	j	j	j	j
Explain physical changes	j	j	j	j	j	j	j	j
Pollution	j	j	j	j	j	j	j	j
Atmosphere	j	j	j	j	j	j	j	j
Sound & vibration	j	j	j	j	j	j	j	j
Cells	j	j	j	j	j	j	j	j
Human nutrition	j	j	j	j	j	j	j	j
Building & breaking	j	j	j	j	j	j	j	j
Energy types and conversions	j	j	j	j	j	j	j	j

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Spiral by Design?

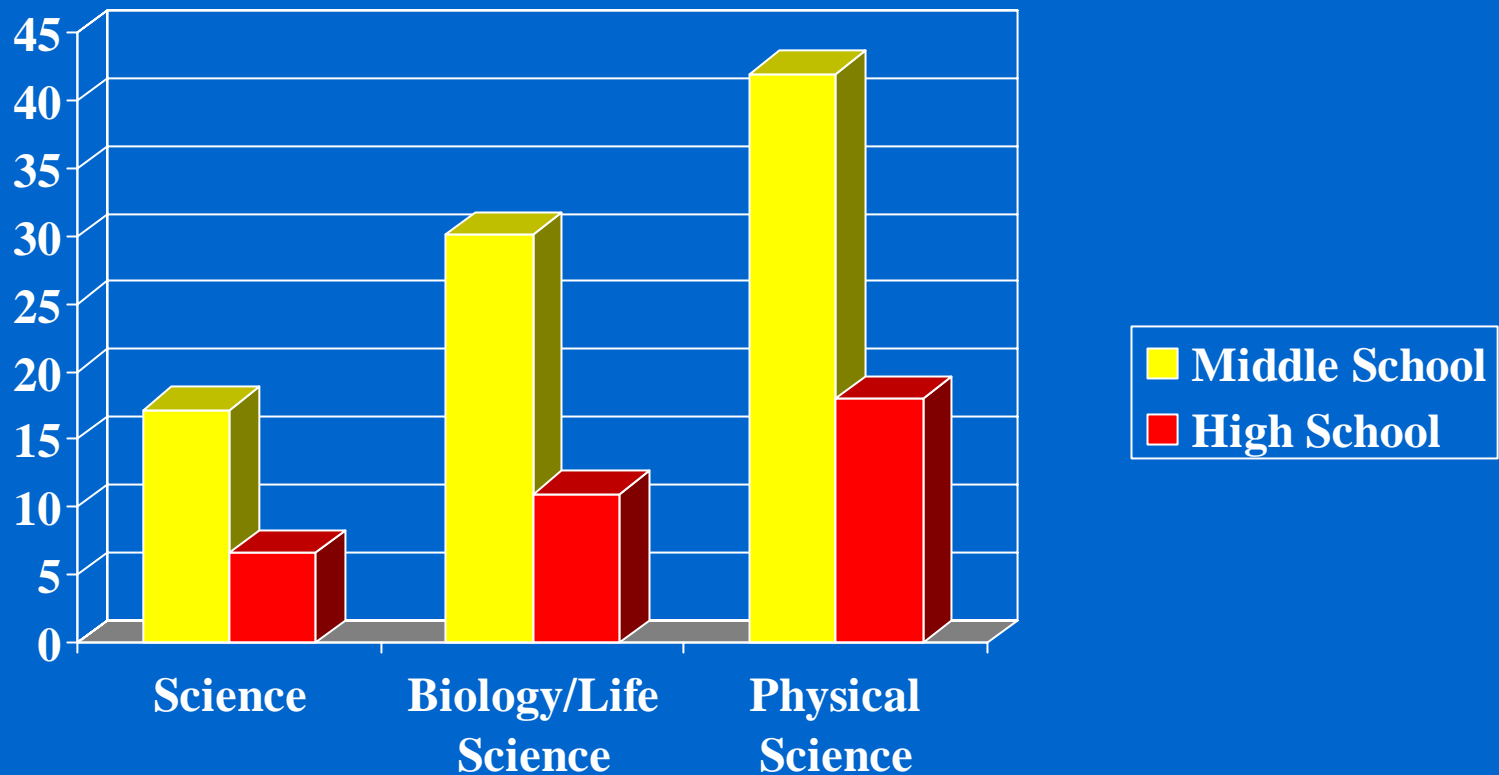
“important concepts and skills are used multiple times at a given grade level and spaced across grade levels”

What can we do to improve?



Teacher Quality

Out-of-field Teaching in Science



Program Implications

- Alternative routes to teaching
- Adjunct and part-time teaching
- Differential pay
 - For performance
 - For shortages
 - For schools of high-need
- Time and support for professional development

What can we do to improve?



Science of learning

Extrapolations are questionable

“Limits or boundaries, defined as constraints for projects, rooms, locations or rules, are great for non-learning activities. However, having limitless boundaries, which focus on defined project parameters will allow learners to think out of the box and learn more concepts, truly reach higher levels of achievement and envision that the sky is really the limit.”

Discovery learning

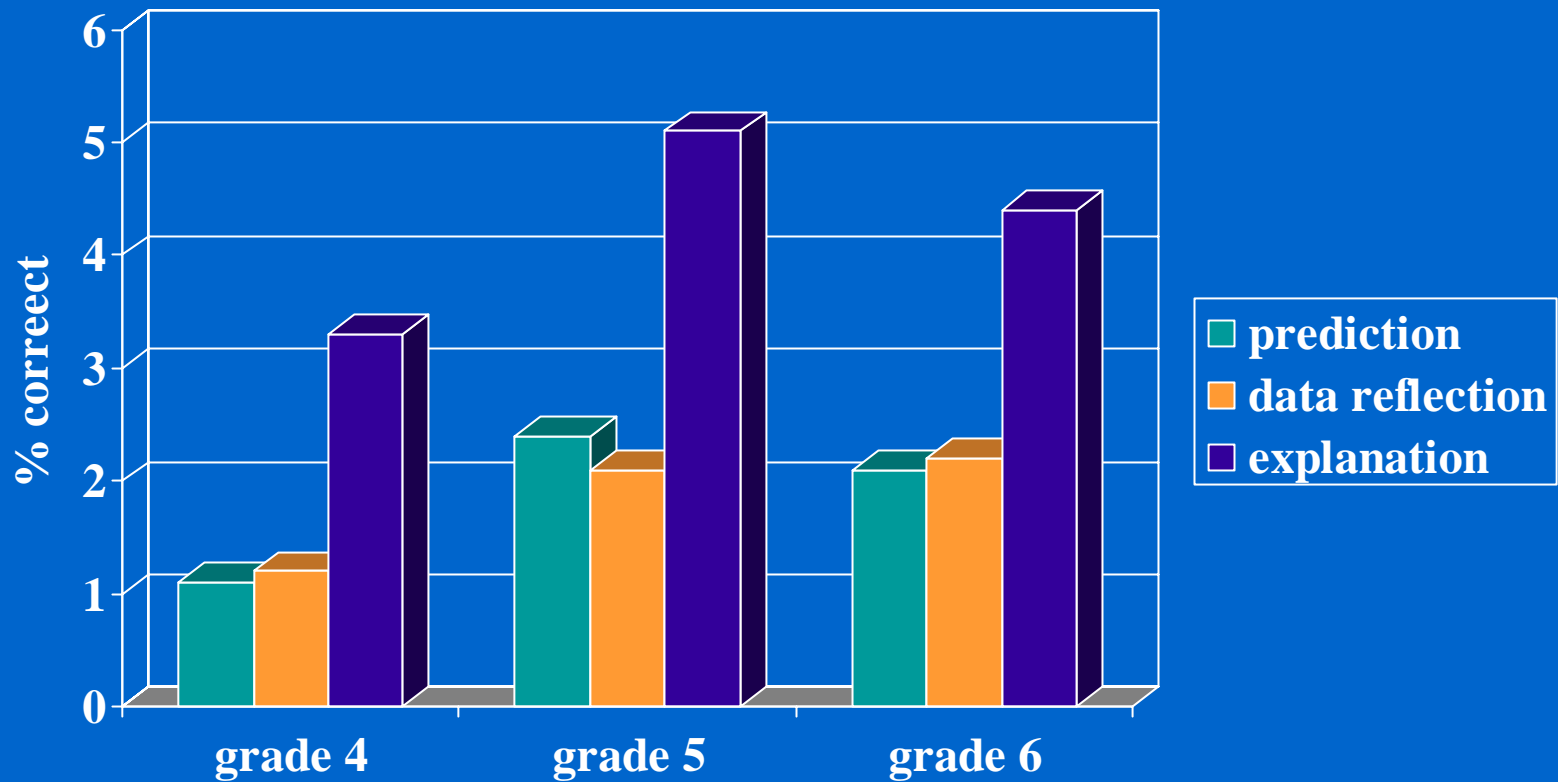
- Piagetian conservation learning
- LOGO programming
- Misconceptions

Misconceptions

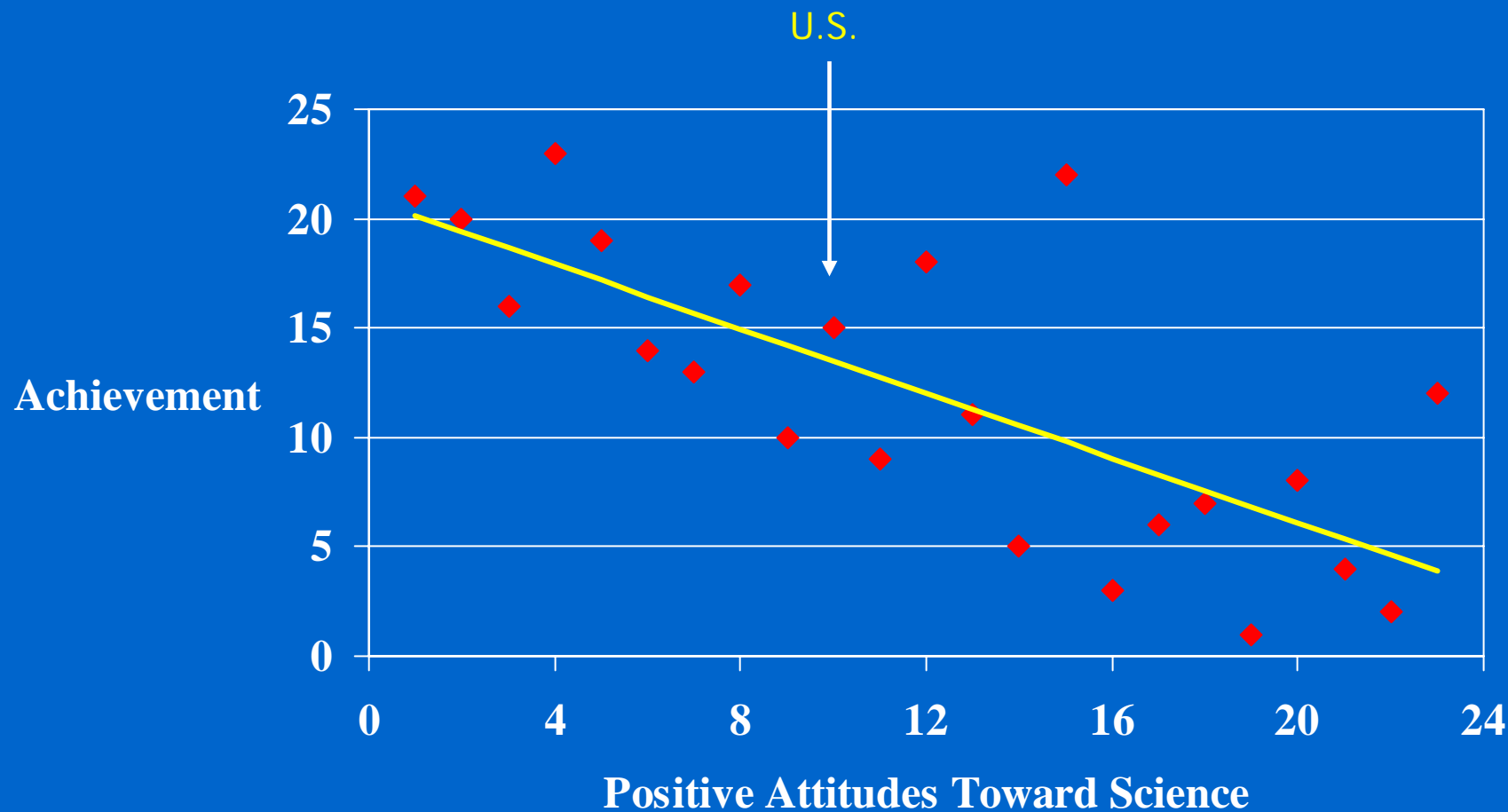
“Heavy things fall faster than light things”

- Discovery theory
 - Discordant observations change concepts

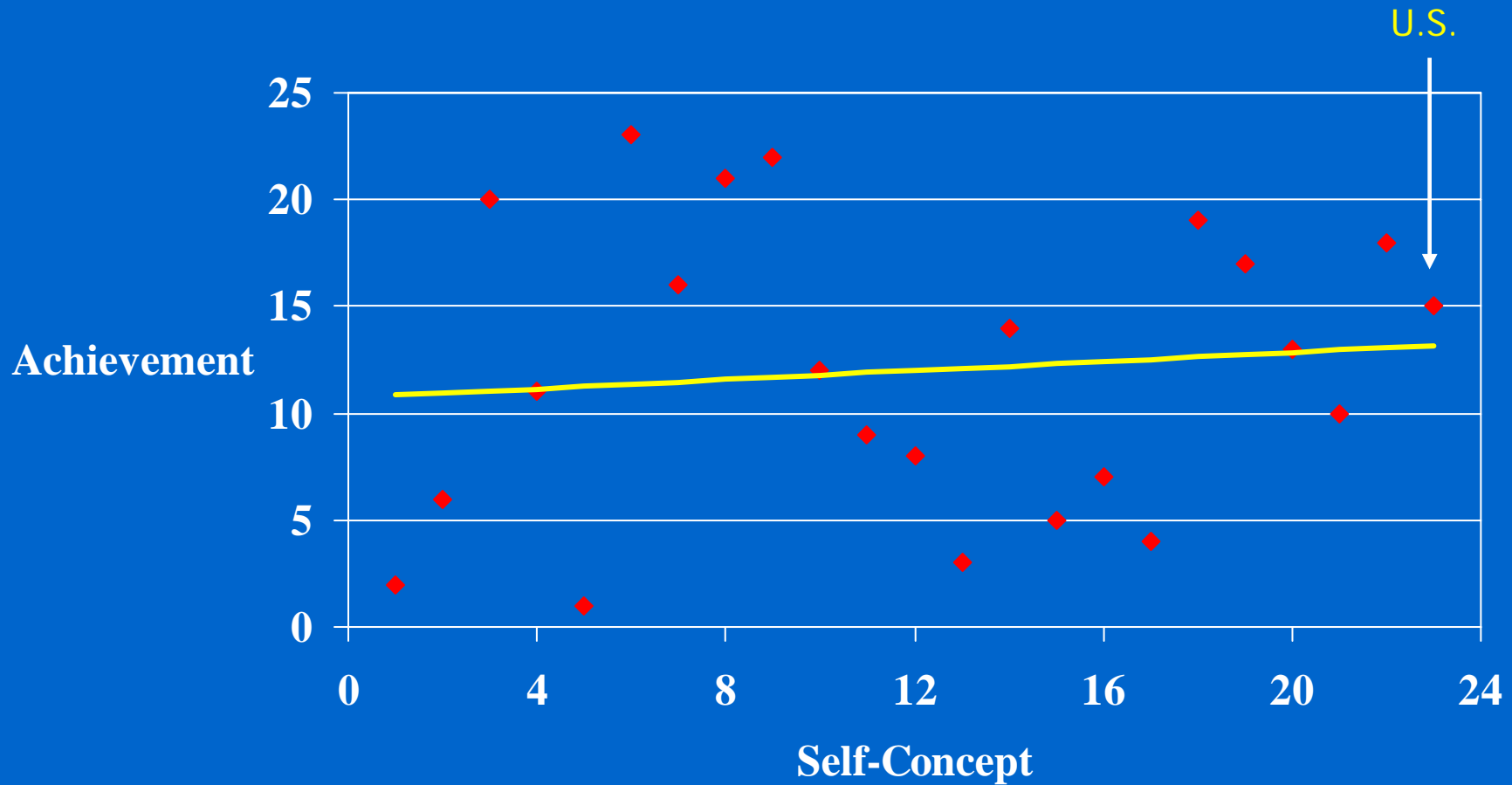
Explaining misconceptions



Positive Attitudes toward Science



Positive Self Concept in Science



Science isn't unique

- Science content shares many similarities with content from other subjects
- Research on reading, thinking, learning, and remembering will prove relevant to science education

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Science: Declarative

Which part of a cell allows nutrients and other materials to enter or leave the cell?

1 cytoplasm

2 nucleus

3 chloroplast

4 cell membrane

Social Studies: Declarative

Where were the Maya and Aztec empires located?

1. Canada
2. Central America
3. southeastern U.S.
4. southwestern Europe

Science: Conceptual

Which color fur will best protect a rabbit from a hawk in a snowy field?

A brown

B gray

C white

D black

Social Studies: Conceptual

“...You furnish the pictures; I’ll furnish the war.”
William Randolph Hearst (to war correspondent
Frederic Remington)

Which cause of the Spanish-American War is most
clearly shown by this statement?

1 imperialism

3 political ambition

2 militarism

4 yellow journalism

What can we do to improve?



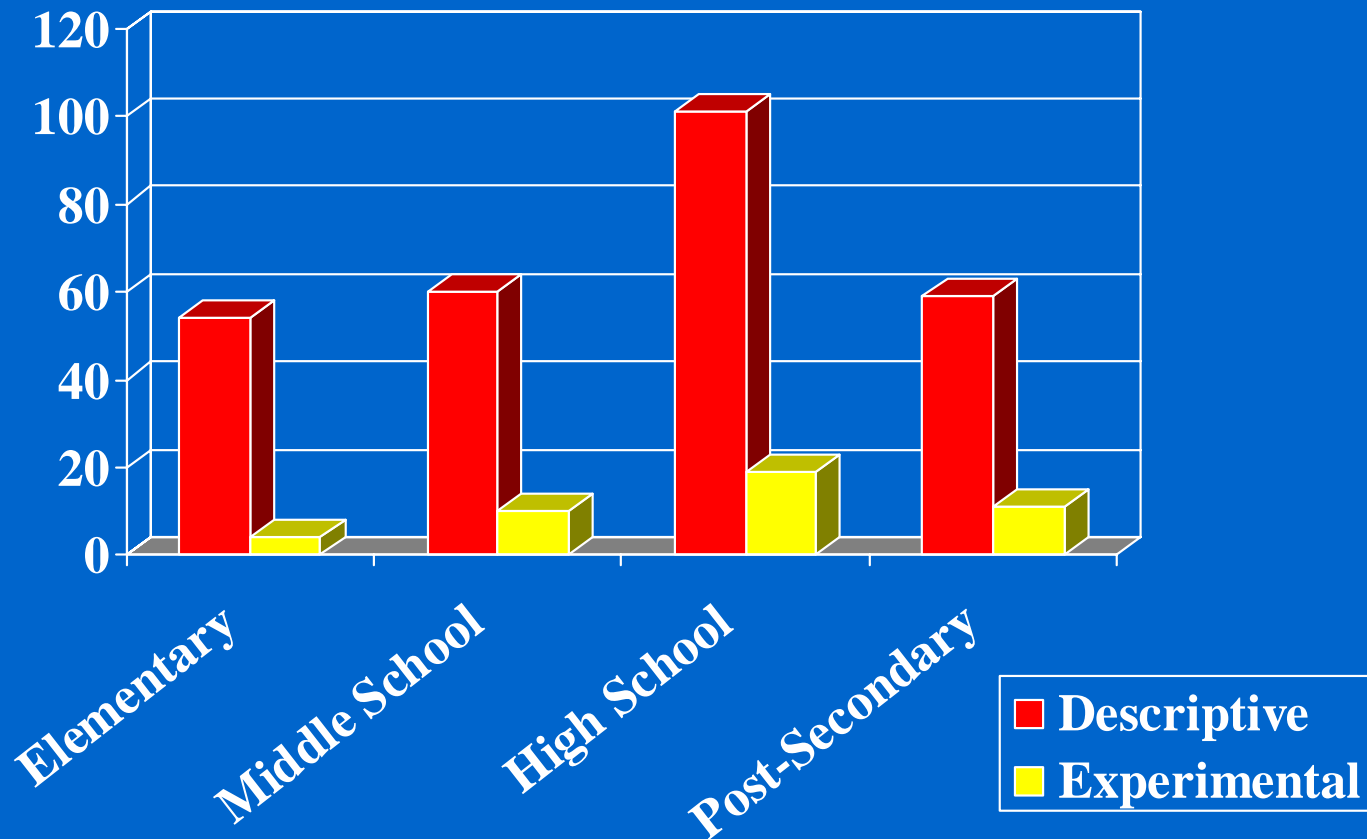
Program Evaluation

Research is Thin

There is something fascinating about science [education]. One gets such wholesale returns of conjecture out of such a trifling investment of fact.

Mark Twain (1835 - 1910)

Type of Research



Policy Implications

- Enhance supply and professional development of qualified teachers
- Develop focused and sequenced curricula
- Increase graduation requirements in math and science, and provide college entrance incentives
- Align teaching methods with content with science of learning
- Evaluate the effects of standards and of programs

The Institute of Education Sciences



*The home of
evidence-based education*